Nomenclature: Naming Ionic and Covalent Compounds

A. Naming Binary Ionic Compounds Containing a Metal Ion with a Fixed Charge (Type I)

A binary ionic compound is composed of ions of two different elements - one of which is a metal, and the other a nonmetal. For example, potassium bromide, KBr, is composed of potassium ions, K^+ (elemental potassium is a metal), and bromide ions, Br^- (elemental bromine is a nonmetal).

1. The cation is written first in the name; the anion is written second in the name.

2. The name of the cation is the same as the (neutral) element from which it is derived (e.g., K^+ = "potassium").

3. The anion is named by adding the suffix *-ide* to the root of the element name (e.g., Br^- = "**brom***ide*").

*Note: Greek prefixes are **not** used to indicate the number of atoms of each element in the formula unit for the compound (e.g., Al_2S_3 is named "aluminum sulfide" not "dialuminum trisulfide").*

Metals That Form Type I Ionic Compounds

Cation	Name	Cation	Name
Li^+	lithium	Ca^{2+}	calcium
Na^+	sodium	Sr^{2+}	strontium
K^+	potassium	Ba^{2+}	barium
Rb^+	rubidium	Al^{3+}	aluminum
Cs^+	cesium	Zn^{2+}	zinc
Be^{2+}	beryllium	Ag^+	silver
Mg^{2+}	magnesium	Cd^{2+}	cadmium

Some Common Anions

Anion	Name
H^-	hydride
F^-	fluoride
Cl^-	chloride
Br^-	bromide
I^-	iodide
O^{2-}	oxide
S^{2-}	sulfide
N^{3-}	nitride

B. Naming Binary Ionic Compounds Containing a Metal Ion with a Variable Charge (Type II)

A binary ionic compound is composed of ions of two different elements - one of which is a metal, and the other a nonmetal. For example, chromium (III) chloride, $CrCl_3$, is composed of chromium ions, Cr^{3+} (elemental chromium is a metal), and chloride ions, Cl^- (elemental chlorine is a nonmetal).

1. The cation is written first in the name; the anion is written second in the name.

2. The name of the cation is the same as the (neutral) element from which it is derived. The charge on the cation is indicated using a Roman numeral, in parentheses, immediately following the name of the cation (e.g., Cr^{3+} = "chromium(III)").

3. The anion is named by adding the suffix *-ide* to the root of the element name (e.g., Cl^- = "**chlor***ide*").

*Note: Greek prefixes are **not** used to indicate the number of atoms of each element in the formula unit for the compound (e.g., FeI_3 is named "iron(III) iodide" not "iron(III) triiodide").*

Some Metals That Form Type II Ionic Compounds and Their Common Charges

Cation	Name	Cation	Name
Cr^{2+}	chromium (II)	Cu^{2+}	copper (II)
Cr^{3+}	chromium (III)	Sn^{2+}	tin (II)
Co^{2+}	cobalt (II)	Sn^{4+}	tin (IV)
Co^{3+}	cobalt (III)	Mn^{2+}	manganese (II)
Fe^{2+}	iron (II)	Ni^{2+}	nickel (II)
Fe^{3+}	iron (III)	Pb^{2+}	lead (II)
Cu^{+}	copper (I)	Pb^{4+}	lead (IV)

C. Naming Ionic Compounds Containing Polyatomic Ions

Polyatomic ions are ions which consist of more than one atom. For example, nitrate ion, NO_3^-, contains one nitrogen atom and three oxygen atoms. The atoms in a polyatomic ion are usually covalently bonded to one another, and therefore stay together as a single, charged unit.

1. The cation is written first in the name; the anion is written second in the name.

2. When the formula unit contains *two or more* of the *same* polyatomic ion, that ion is written in parentheses with the subscript written outside the parentheses.

Note: Parentheses and a subscript are <u>not</u> used unless more than one of a polyatomic ion is present in the formula unit (e.g., the formula unit for ammonium chloride is "NH_4Cl" not " $(NH_4)Cl$ ").

3. If the cation is a metal ion with a fixed charge, the name of the cation is the same as the (neutral) element from which it is derived (e.g., Mg^{2+} = "magnesium"). If the cation is a metal ion with a variable charge, the charge on the cation is indicated using a Roman numeral, in parentheses, immediately following the name of the cation (e.g., Cu^{+} = "copper (I)").

4. If the anion is a monatomic ion, the anion is named by adding the suffix *-ide* to the root of the element name (e.g., I^{-} = "iodide").

*Note: Greek prefixes are **not** used to indicate the number of atoms, or polyatomic ions, in the formula unit for the compound (e.g., $Ba(ClO_3)_2$ is named "barium chlorate" not "barium dichlorate").*

Some Metals Common Polyatomic Ions

Polyatomic Ion	Formula	Polyatomic Ion	Formula
acetate	$C_2H_3O_2^-$	hypochlorite	ClO^-
carbonate	CO_3^{2-}	chlorite	ClO_2^-
bicarbonate (hydrogen carbonate)	HCO_3^-	chlorate	ClO_3^-
hydroxide	OH^-	perchlorate	ClO_4^-
nitrate	NO_3^-	permanganate	MnO_4^-
nitrite	NO_2^-	sulfate	SO_4^{2-}
chromate	CrO_4^{2-}	sulfite	SO_3^{2-}
dichromate	$Cr_2O_7^{2-}$	hydrogen sulfite (bisulfite)	HSO_3^-
phosphate	PO_4^{3-}	hydrogen sulfate (bisulfate)	HSO_4^-
hydrogen phospahte	HPO_4^{2-}	peroxide	O_2^{2-}
ammonium	NH_4^+	cyanide	CN^-

D. <u>Rules for Naming Binary Molecular (Covalent) Compounds</u>

A binary covalent compound is composed of two different nonmetal elements. For example, a molecule of nitrogen dioxide, NO_2 contains 1 nitrogen atom and 2 oxygen atoms.

1. The element with the lower group number is written first in the name; the element with the higher group number is written second in the name.

Exception: when the compound contains oxygen and a halogen (group 7A (17)), the name of the halogen is the <u>first</u> word in the name.

2. If both elements are in the same group, the element with the higher period number is written first in the name.

3. The second element in the name is named as if it were an anion, i.e., by adding the suffix *-ide* to the name of the element.

4. Greek prefixes (see the Table provided at the bottom of this page) are used to indicate the number of atoms of each nonmetal element in the chemical formula for the compound.

> ***Exception: if the compound contains one atom of the element that is written first in the name, the prefix "mono-" is <u>not</u> used.***

Note: when the addition of the Greek prefix places two vowels adjacent to one another, the "a" (or the "o") at the end of the Greek prefix is usually dropped; e.g., "nonaoxide" would be written as "nonoxide", and "monooxide" would be written as "monoxide". The "i" at the end of the prefixes "di-" and "tri-" are never dropped.

prefix	**number indicated**
mono-	1
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8
nona-	9
deca-	10

E. <u>Naming Binary Acids</u>

Acids are molecular compounds that dissolve in water to form H^+ ions. Binary acids are composed of hydrogen and a nonmetal. For example, hydrochloric acid, HCl contains hydrogen and a chlorine atom.

1. Write the prefix *hydro-* followed by the base name of the nonmetal and add the suffix *-ic* (e.g. HCl – *hydro***chlor***ic*).

2. Add the word acid after the name of the acid (e.g. HCl – hydrochloric **acid**).

*Note: Greek prefixes are **not** used to indicate the number of atoms of each element in the formula unit for the compound (e.g., Na_2O is named "sodium oxide" not "disodium oxide", or "disodium monoxide").*

F. Naming Oxyacids

Oxyacids are derived from oxyanions. For example, nitric acid, HNO_3 is derived from the nitrate (NO_3^-) ion, and sulfuric acid, H_2SO_4 is derived from the sulfate (SO_4^{2-}). Oxyacids are composed of hydrogen and an oxyanion.

1. If the oxyanion ends in –ate, write the base name of the oxyanion and add the suffix *–ic* (e.g. HNO_3 – **nitr***ic*).

2. If the oxyanion ends in –ite, write the base name of the oxyanion and add the suffix *–ous* (e.g. HNO_2 – **nitr***ous*).

3. Add the word acid after the name of the acid (e.g. HNO_3 – nitric **acid**).

*Note: Greek prefixes are **not** used to indicate the number of atoms of each element in the formula unit for the compound (e.g., Na_2O is named "sodium oxide" not "disodium oxide", or "disodium monoxide").*

*Information obtained (with some modifications) from: http://www.chem.purdue.edu/gchelp/